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CURRENT AND PROJECTED ENERGY SITUATION IN THE ESCAP REGION

(Item 4 of the provisional agenda)

Note by the secretariat

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I. ENERGY RESOURCES DEVELOPMENTS

Introduction

In this paper, energy resources, trends in energy consumption and the current situation of energy development in the ESCAP region are reviewed, using the most recent statistics and publications as far as possible. With regard to energy resources in the region, reference was made to the Survey of Energy Resources, which was published by the World Energy Conference, held in the Federal Republic of Germany in 1980. As far as definitions are concerned, "solid fossil fuels" include anthracite, bituminous coal, sub-bituminous coal, lignite and peat; "hydrocarbons" include crude oil, natural gas liquids, natural gas, bituminous sand and oil shale. "Proved recoverable reserves" mean the fraction of total resources that can be recovered under present and expected local economic conditions with existing available technology. "Estimated additional resources" mean all resources, other than proved reserves, that are of at least foreseeable economic interest.

Hydro resources are discussed together with electricity developments in chapter II of this paper.

The latest regional statistics concerning energy resources are given in the document entitled "Latest energy statistics".

As to the primary energy production and consumption in the region, use was made of the 1979 Yearbook of World Energy Statistics, which was published by the United Nations in 1981. As the 1980 statistics could not be obtained in time, the 1979 statistics were used. As far as definitions are concerned, "solids" mean the same as solid fossil fuels mentioned above, "liquids" mean crude oil and natural gas liquids and "electricity" means hydro, nuclear and geothermal electricity.

Fuelwood and charcoal are widely used and still play a very significant role in the region, but since the conversion factors are not available, those were excluded in this study.[1/]

Regional statistics concerning primary energy production and consumption are given in the document entitled "Latest energy statistics".

/Finally,

1/ Note, however, the discussion in footnote 6 below.

Finally, as to the current situation of energy development in the region, use was made, among other sources, of various periodicals and magazines including, World Oil of 15 August 1980 concerning each country's hydrocarbons development, and Petroleum Economist of December 1980 concerning liquefied natural gas (LNG) trade development.

A. ENERGY RESOURCES IN THE REGION

The Survey of Energy Resources published by the World Energy Conference in 1980 shows the latest statistics concerning energy reserves and resources in the world. From these statistics, the following indications can be given of the features of the region.

1. Solid fossil fuels

Total proved recoverable reserves of solid fossil fuels in the region are 151 billion TCE (metric tons of coal equivalent), which account for 22 per cent of the world total. The country with the largest endowment is China, with a share amounting to 65.5 per cent of the region. The second largest is Australia, whose share is 24 per cent. Therefore, around 90 per cent of solid fossil fuel reserves in the region are concentrated in these two countries.

The static lifetime (reserves/production ratio) of solid fossil fuels in the region is about 200 years,[2/] and if estimated additional resources are included, this could indicate that solid fossil fuels in the region are quite abundant from the viewpoint of resources.

Table 1

Solid fossil fuels resources in the ESCAP region

Country	Proved recoverable reserves		Additional resources		Total reserves and resources	
	Volume (million TCE)	Share %	Volume (million TCE)	Share %	Volume (million TCE)	Share %
Australia	36 302.0	24.0	611 600.0	29.7	647 902.0	29.3
China	99 000.0	65.5	1 339 838.0	65.0	1 438 838.0	65.0
India	13 134.0	8.7	91 231.7	4.4	104 365.7	4.7
Indonesia	234.1	0.2	14 591.5	0.7	14 825.6	0.7
Japan	1 055.9	0.7	215.0	0.0	1 270.9	0.1
New Zealand	161.9	0.1	2 213.3	0.1	2 375.2	0.1
Republic of Korea	116.3	0.1	1 049.0	0.0	1 165.3	0.0
Others	1 145.1	0.7	1 528.8	0.1	2 673.9	0.1
Regional total	151 149.3	100/218	2 062 267.3	100/204	2 213 416.6	100/205
World total	693 269.9	100.0	10 102 357.4	100.0	10 795 627.3	100.0

Source: World Energy Conference, Survey of Energy Resources, 1980.

2/ Solid fossil fuels 151/0.743 (production in 1979) = 203.

2. Hydrocarbons

Total recoverable reserves of hydrocarbons in the region are 48 billion TCE (crude oil 21 billion TCE, natural gas 24 billion TCE, oil shale 3 billion TCE), accounting for 13 per cent of the world total.

The static lifetime of gaseous and liquid hydrocarbons is around 60 years,[3/] and it seems that gaseous and liquid hydrocarbons in the region are scarce compared with solid fossil fuels. But when observed in detail, it is found that natural gas is rather abundant (static lifetime is more than 250 years,[4/] while liquids are quite scarce (static lifetime is only around 30 years.[5/] This is due to the comparatively low level of development and utilization of existing natural gas reserves.

As the figures for the production of hydrocarbons in the region in 1979 are anomalous because of the sudden decline of Iranian production, the 1978 production figures are used for calculating static lifetimes.

(a) Crude oil

Total proved recoverable reserves of crude oil in the region are 21 billion TCE, accounting for 15 per cent of the world total. The country with the largest endowment is Iran, whose share in the region is 61.4 per cent. The second largest is China, and the third largest Indonesia, whose shares in the region are 20.5 and 10.6 per cent respectively. These three countries have more than 90 per cent of regional crude oil reserves. But if we take the estimated additional resources into consideration, India becomes the second largest next to Iran, and Australia becomes the fourth largest next to China, lying before Indonesia.

(b) Natural gas

Total proved recoverable reserves of natural gas in the region are 24 billion TCE, accounting for 25 per cent of the world total. With regard to natural gas reserves, the region has quite abundant supplies at the current production level. The country with the largest endowment in the region is Iran, whose weight in the region is 78.6 per cent. Other countries which have relatively sizable reserves are Malaysia, China, Indonesia and Pakistan. However, taking estimated additional resources into account, India takes second place behind Iran and Australia takes third place.

/Table 2

3/ Hydrocarbons 48/0.832 (production in 1978) = 58.

4/ Natural gas 24/0.093 (production in 1978) = 258.

5/ Liquids (including oil shale) 24/0.739 (production in 1978) = 32.

Table 2

Crude oil resources in the ESCAP region

Country	Proved recoverable reserves		Additional resources		Total reserves and resources	
	Volume (million TCE)	Share %	Volume (million TCE)	Share %	Volume (million TCE)	Share %
Australia	415.3	2.0	2 237.5	18.6	2 652.8	8.2
Brunei	309.9	1.5	-	-	309.9	0.9
China	4 183.6	20.5	-	-	4,183.6	12.9
India	496.3	2.4	9 761.8	81.4	10 258.1	31.6
Indonesia	2 169.3	10.6	-	-	2 169.3	6.7
Iran	12 550.8	61.4	-	-	12 550.8	38.7
Malaysia	211.8	1.0	-	-	211.8	0.6
Others	120.9	0.6	-	-	120.9	0.4
Regional total	20 457.9	100/14.8	11 999.3	100/14.5	32 457.2	100/14.7
World total	138 040.3	100.0	82 722.0	100.0	220 762.3	100.0

Source: World Energy Conference, Survey of Energy Resources, 1980.

Table 3

Natural gas resources in the ESCAP region

Country	Proved recoverable reserves		Additional resources		Total reserves and resources	
	Volume (million TCE)	Share %	Volume (million TCE)	Share %	Volume (million TCE)	Share %
Australia	426.3	1.8	3 463.9	24.3	3 890.2	10.7
Bangladesh	-	-	242.0	1.7	242.0	0.6
Brunei	309.3	1.3	-	-	309.3	0.8
China	954.7	4.0	-	-	954.7	2.5
India	102.1	0.4	10 085.3	70.8	10 187.4	26.7
Indonesia	914.4	3.8	-	-	914.4	2.4
Iran	18 825.9	78.6	-	-	18 825.9	49.3
Malaysia	1 111.7	4.6	-	-	1 111.7	2.9
New Zealand	227.3	0.9	295.8	2.1	523.1	1.4
Pakistan	785.3	3.3	161.4	1.1	946.7	2.5
Thailand	158.7	0.7	-	-	158.7	0.4
Others	124.9	0.6	-	-	124.9	0.3
Regional total	23 940.6	100/25.4	14 248.4	100/7.7	38 189.0	100/13.7
World total	94 123.7	100.0	185 105.9	100.0	279 229.1	100.0

Source: World Energy Conference, Survey of Energy Resources, 1980.

B. TRENDS IN ENERGY CONSUMPTION IN THE REGION

The following trends emerge in primary energy consumption in the ESCAP region.

1. General

(a) Regional primary energy consumption comprises solids (48.6 per cent), liquids (43.0 per cent), gas (5.8 per cent) and electricity (2.6 per cent), while the world average in solids is 31.5 per cent, liquids 44.0 per cent, gas 21.2 per cent and electricity 3.3 per cent. In comparison with the world average, the regional proportion of solids is quite high, but that of gas is considered to be low.

(b) The average annual increase of primary energy consumption in the region is 5.9 per cent (1970-1979). The region shows quite high increases in energy consumption compared with the world average (3.3 per cent). The developing countries in the region particularly show a high increase (7.3 per cent), higher than the world developing countries' average (6.8 per cent).

Table 4

Primary energy consumption in the ESCAP region

Area	Source	1970 Volume (million TCE)	1970 Share %	1979 Volume (million TCE)	1979 Share %	(1970-1979) Average annual increase rate (%)
ESCAP	Solids	492.959	52.8	759.247	48.6	4.9
	Liquids	387.229	41.4	671.371	43.0	6.3
	Gas	32.359	3.5	89.708	5.8	12.0
	Electricity	21.658	2.3	40.702	2.6	7.3
	Total	934.205	100.0	1 561.028	100.0	5.9
WORLD	Solids	2 271.798	34.9	2 738.260	31.5	2.1
	Liquids	2 792.284	42.9	3 833.928	44.0	3.6
	Gas	1 293.467	19.8	1 845.932	21.2	4.0
	Electricity	154.872	2.4	287.783	3.3	7.1
	Total	6 512.421	100.0	8 705.903	100.0	3.3

Source: United Nations, 1979 Yearbook of World Energy Statistics.

However, that of the regional developed countries is not so high (3.5 per cent), although it is still higher than the world developed countries' average (1.9 per cent). Generally speaking, energy consumption in the region has increased rapidly during the 1970s, perhaps at the highest rate in the world.

(c) In spite of the high increase rate in energy consumption, the regional average per capita energy consumption is still low. Regional average per capita energy consumption is around 0.66 TCE, which is far below the world average (2.0 TCE).6/ Furthermore, that of developing countries in the region is 0.46 TCE (while that of developed countries in the region is 4.0 TCE), and if China, whose per capita consumption is 0.73 TCE is excluded, that figure decreases to only 0.26 TCE. It is thus lower than the world developing countries' average (0.44 TCE).

2. Solids

Solids represent the most widely used energy source in the region. Solids consumption of the region accounts for 28 per cent of the world total. China is the largest consumer of solids, accounting for 71.4 per cent of the region. Next to China, India and Japan consume sizable volumes, their shares in the region being 9.7 and 9.1 per cent respectively. The above three countries consume around 90 per cent of the regional total. With regard to the average annual increase rate of solids consumption, the regional average is 4.9 per cent (1970-1979), which is more than twice the world average (2.1 per cent). In particular, China's increase rate is quite high (6.5 per cent), while Japan shows a decline at the rate of 2.3 per cent. The other countries' average increase rate is 4.5 per cent, which is still higher than the world average.

3. Liquids

Liquids are also consumed widely in the region. Liquids consumption of the region accounts for 18 per cent of the world total. The largest consumer in the region is Japan, accounting for 47.0 per cent of the regional total. China is the second largest consumer, accounting for 17.6 per cent. Among the other countries, Australia, India, Indonesia, Iran and the Republic of Korea consume relatively large volumes. With regard to the annual increase

/rate,

6/ Even adding an estimated 400 kg per capita annual traditional fuel consumption (wood and animal waste), the average would be less than half the world average consumption.

rate, the regional average is 6.3 per cent (1970-1979), higher than the world average (3.6 per cent). Although Japan shows only a 4.3 per cent increase, other countries show a more rapid increase (8.5 per cent). China's increase rate is by far the highest at 15.8 per cent.

Table 5

Solids consumption in the ESCAP region

Country	1970 Volume (million TCE)	1970 Share %	1979 Volume (million TCE)	1979 Share %	(1970-1979) Average annual increase rate (%)
Australia	31.258	6.3	41.515	5.5	3.2
China	307.872	62.5	542.428	71.4	6.5
India	51.421	10.4	73.707	9.7	4.1
Japan	85.531	17.4	69.280	9.1	2.3
Others	16.877	3.4	32.317	4.3	7.5
Regional total	492.959	100/21.7	759.247	100/27.7	4.9
World total	2 271.798	100.0	2 738.260	100.0	2.1

Source: United Nations, 1979 Yearbook of World Energy Statistics.

Table 6

Liquids consumption in the ESCAP region

Country	1970 Volume (million TCE)	1970 Share %	1979 Volume (million TCE)	1979 Share %	(1970-1979) Average annual increase rate (%)
Australia	29.780	7.7	37.007	5.5	2.5
China	31.545	8.1	118.001	17.6	15.8
India	20.888	5.4	34.886	5.2	5.9
Indonesia	11.937	3.1	24.576	3.7	8.4
Iran	12.158	3.1	30.328	4.5	10.7
Japan	216.413	55.9	315.574	47.0	4.3
Republic of Korea	12.019	3.1	33.629	5.0	12.1
Others	52.489	13.6	77.370	11.5	4.4
Regional total	387.229	100/13.9	671.371	100/17.5	6.3
World total	2 792.284	100.0	3 833.928	100.0	3.6

Source: United Nations, 1979 Yearbook of World Energy Statistics.

4. Gas

Gas is not consumed so much in the region in spite of its comparatively large potential. Gas consumption of the region accounts for only 5 per cent of the world total.

Japan is the largest consumer in the region, accounting for 32 per cent of the total. Other large consumers are China and Iran, whose shares in the region are 21.5 and 11.5 per cent respectively. In addition, Australia, Indonesia and Pakistan are also relatively sizable consumers.

The regional average annual increase rate is 12.0 per cent (1970-1979) and this is three times larger than the world average (4.0 per cent). Japan's increase rate is quite high (21.3 per cent), although that of the other countries is still higher (9.3 per cent) than the world average (4.0 per cent).

Table 7

Gas consumption in the ESCAP region

Country	1970 Volume (million TCE)	1970 Share %	1979 Volume (million TCE)	1979 Share %	(1970-1979) Average annual increase rate (%)
Australia	1.911	5.9	9.434	10.5	19.4
China	4.913	15.2	19.306	21.5	16.4
Indonesia	1.596	4.9	6.452	7.2	16.8
Iran	14.260	44.1	10.339	11.5	3.5
Japan	5.027	15.5	28.567	31.9	21.3
Pakistan	3.267	10.1	7.020	7.8	8.9
Others	1.385	4.3	8.590	9.6	22.5
Regional total	32.359	100/2.5	89.708	100/4.9	12.0
World total	1 293.467	100.0	1 845.932	100.0	4.0

Source: United Nations, 1979 Yearbook of World Energy Statistics.

C. THE CURRENT SITUATION OF HYDROCARBON DEVELOPMENTS IN THE REGION

The ESCAP region comprises seven energy-exporting countries (Afghanistan, Australia, Brunei, China, Indonesia, Iran and Malaysia) and many other energy-importing countries. In spite of this, the regional energy balance in the 1970s was comparatively good. In 1979, mainly because

/of

of a sudden decline of Iran's oil and gas production, the regional energy balance suddenly became worse and turned into a deficit for the first time in the 1970s.

If Iranian production recovers and/or Australian coal exports increase, the over-all balance might again be positive. Nevertheless, because regional consumption will continue to increase at a higher pace than the world average, it is necessary for each country in the region to develop indigenous energy resources as quickly as possible. However, as it will take a few decades to utilize non-conventional energy resources to an appreciable extent, the development of conventional energy resources, namely, coal, oil, gas and hydro and nuclear power, is indispensable, in order to avoid a regional energy deficit.

In this paper, the current situation of hydrocarbon developments in the region is surveyed, with particular emphasis on natural gas, which has been hardly exploited in spite of the existing comparatively large endowment.

Although Bangladesh has large natural gas reserves, it has not been able to exploit them because of a comparative lack of capital and expertise and low domestic demand. However, as it reached an agreement with the United Kingdom to obtain a grant in 1979, and also because it may reach a sales agreement with India for some of its production, it is quite probable that Bangladesh will become a large natural gas producer in the near future.

India has been very positive in exploring its indigenous crude oil reserves and it is expected that the production from Bombay High, which is one of the largest crude oil reserves in India, will increase from 100,000 bpd (barrels per day) in 1979 to 240,000 bpd by mid-1982. With this increase in Bombay High's production, India could reduce its dependence on imported energy considerably.

Pakistan also hopes to develop its crude oil reserves and is planning to supply half of its oil requirements - 50,000 bpd - domestically by 1982. With a $US 30 million loan from the World Bank, Pakistan plans to increase production from the Tut oil field from a current 2,500 bpd to 10,000 bpd by 1982. Furthermore, with $US 85 million financed by the Government, the production from the Mayal oil field, where current production is 7,500 bpd, will be boosted to 17,000 bpd and the capacity of the two topping plants (distillers) will also be increased from the current 5,000 bpd to 20,000 bpd.

Thailand, which has been almost wholly dependent on imported energy, will begin to utilize its indigenous natural gas from the "A" structure this September. The production from the "A" structure will rise to 250 mcfd

/(million

(million cubic feet per day) of natural gas and 8,200 bpd of condensate by 1983. In addition, the "B" structure is to be developed following the "A" structure, with an initial flow of 150 mcfd. The production is expected to increase to 350 mcfd by the eighth year of production. As far as the "B" structure is concerned, negotiations are under way between Thailand and Japan to set up a liquefaction plant at Songkhla.

With regard to the LNG trade, the ESCAP region is one of the most advanced areas in the world. There are two LNG-exporting countries in the region: Indonesia and Brunei. Indonesia exported 834 mcfd of LNG and Brunei 732 mcfd (to Japan) in 1979. These two countries accounted for about half the world total of LNG exports in 1979. Although Japan is the only LNG-importing country in the region, as it also imports LNG from the United States of America and the United Arab Emirates, the ESCAP region consumes more than half the LNG of the world. Furthermore, Japan is planning to import LNG additionally from Indonesia, and also from Malaysia and Australia, as mentioned below. The ESCAP region is expected to continue to be the focus of LNG trade in the near and medium-term future.

Indonesia has two liquefaction plants: one at Badak in east Kalimantan and the other at Arun in northern Sumatra, where current liquefaction capacities are 410 mcfd and 640 mcfd respectively. Indonesia signed an agreement with Japan this year to supply 835 mcfd of LNG additionally from 1983, of which 410 mcfd will come from Badak and 425 mcfd from Arun.

Furthermore, negotiations are under way between Indonesia and the Republic of Korea to provide some 210 mcfd of LNG from Arun from 1985. If all these plans are carried out, Indonesia will be one of the largest exporters in the world, equal to Algeria.

Malaysia also signed an agreement with Japan in 1979 to provide 850 mcfd of LNG from Bintulu, in Sarawak, from 1983. In addition, negotiations are under way between Australia and Japan to provide 800 mcfd of LNG from the North-West Shelf from 1986.

As mentioned before, the ESCAP region is quite rich in natural gas reserves. However, mainly because of the long distances between producing areas and consuming areas, natural gas has barely been explored, and the consumption of natural gas is still at a low level in the region.

The extensive experience in LNG trade in the region is valuable. It will be of great help to continue to develop a regional trade of natural gas in the future. From that point of view, we can expect that natural gas will be one of the most important transition energy resources in the region during the next decades.

II. ELECTRICITY DEVELOPMENTS

Introduction

This section contains the latest electric power information and statistical data available to the secretariat.

First, a brief analysis of the status of electricity in the ESCAP countries before and after the sudden oil price increases in the last quarter of 1973 may be of interest. A picture of the generalized electric power situation in the region as a whole is presented, together with the situation in some of the individual countries of the region followed by a likely future scenario up to 1995. Because of the unavailability of the latest data/ information from some of the countries of the region, the figures quoted here may differ somewhat from current actual consumption and production levels.

The countries of this region cover a wide range of developmental situations. Some are highly industrialized. Some are agriculture-oriented and some are partly industrialized. This development situation governs the pattern of the electric power demand and its growth. Therefore, the search for a regional indication is unavoidably limited in scope and plagued by over-aggregation. The electric power demand and development are different from one country to another. However, most of the countries in the region are developing countries. They have diverse individual patterns of electric power development. Consequently, particular emphasis has been given to the developing countries of the region.

To speak of the latest energy crisis, the progress of electric power growth in this region in particular has slowed down (though not too seriously) in all the countries. Most of the electric power industries are still highly dependent on imported energy (particularly oil) except for some of the countries which have their own energy reserves.

A. ELECTRICITY GENERATION GROWTH IN THE PAST

In the region as a whole, the generation of electricity showed a steady growth until 1973, in the last quarter of which the large oil price increase occurred. Progress in the electricity supply industries was reasonably good. The growth in generation of the region as a whole during the period 1970-1973 was from 539,602 million kWh to 702,015 million kWh, an average annual increase of 9.1 per cent. But the increase of generation growth in the year 1974 dropped to only 0.5 per cent following the oil price increase in 1973. However, it should be noted that, although in some of the countries of the region no immediate effect was noticed, a resultant delayed after-effect

/did

did occur. This may have been due to the relatively smaller generating systems, requiring a smaller amount of oil, so that no immediate scarcity occurred in some of the countries. Japan, being a large importer of oil, was immediately affected. Japan's electricity generation accounted for more than half the region's generation at exactly 65.8 per cent in 1974. As a result of a 2.4 per cent recorded decrease in generation in Japan that year, the increase in generation of the region as a whole showed a sharp fall to 0.5 per cent, although some of the countries did record increases. Other countries or areas experiencing a serious immediate set-back in generation in that year were Hong Kong (a decrease by 1.3 per cent), New Zealand (a drop to 1.3 per cent from 4.7 per cent growth in 1973, compared with an 8.8 per cent growth annually in 1970-1973), the Philippines (a decrease by 1.1 per cent), Singapore (a drop to 3.9 per cent from 18.0 per cent in 1973).

After the sharp fall in generation growth in the year 1974, the situation improved during the period 1975-1978. Figure I represents the trend of electricity generation and its growth rate in the region as a whole over the years 1970 to 1978.

As already indicated, the situation in all the countries was not the same because of their different socio-economic structure and developmental situation. It is therefore appropriate to continue to analyse the situation in some selected countries individually.

The pattern of electricity generation growth in Australia during the whole period 1970-1978 showed an average increase of 5.8 per cent, with a minimum of 2.7 per cent in 1976 and a maximum of 11.4 per cent in 1977. Australia, having indigenous oil, was not directly affected by the oil crisis. This could be observed as a steady above-average increase of 6.4 per cent during 1973, 1974 and 1975, but a drop in 1976 to 2.7 per cent, indicating a time lag between the recession in the industrialized countries and the effect on the supplier of raw materials.

India has a mixed power system, consisting of hydro, thermal and nuclear power stations. In addition, there are some reserves of the main commercial energy sources of coal, oil, natural gas and hydro power. As a result, a generation growth rate of 7.6 per cent annually was achieved in India during the period 1970-1977 (the 1978 figure is not available), with relatively lower rates of 3.2 per cent in 1973 and 5.3 per cent in 1974. These lower rates were due to a shortage of incremental energy in those years. Thus the situation indicated a different set of circumstances.

/New Zealand

New Zealand, however, was greatly affected by the effects of oil price changes. Although the generation growth rate recovered after 1974, it was still lower than the regional average. During the period 1975-1978, the average annual generation growth was 4.3 per cent (with the lowest yearly growth of 1.7 per cent in the year 1977), compared with 8.8 per cent per annum during the period 1970-1973.

Hong Kong, the Philippines, Singapore and Thailand improved considerably in their generation growth. While their average annual generation growth rates during the period 1970-1973 were 10.3, 12.8, 19.9 and 18.9 per cent, after the 1974 drop, rates recovered to 11.5, 5.3, 11.2 and 14.1 per cent respectively during the period 1975-1978.

Japan recovered its generation growth almost to the regional level after 1974, showing a 5.1 per cent average annual growth during the period 1975-1978, but to only about half the level of its own previous growth rate (10.5 per cent annaul increase during the 1970-1973 period).

From figure I it can be seen that, for the region as a whole, the long-term rate of growth showed a pattern of relatively constant rate of increase, a pause, and then what became a further relatively constant (but lower) rate of increase. The general picture that emerges is that the generation in the region is greatly influenced by the energy situation but the total effect in any individual country is related to the degree of dependence on the price of oil, reservoir water conditions and on the status of the primary products markets (owing to reduced possibility of export and thus balance of payments restrictions).

B. THE PAST TREND OF GENERATION CHANGES, BY TYPE OF PLANT

After the oil crisis in the year 1973, several measures were taken in the countries of the region to reduce dependence on oil. Some of these measures included exploration for indigenous fuel resources and increase in their production, developing and/or increasing the use of alternative sources of energy such as hydro-electric and nuclear power, increasing the use of coal and natural gas where available, using LNG instead of oil, conserving energy, increasing efficiency of use and reducing system losses.

During the period 1970-1973 and even before that, the tendency of electrical industries was towards the use of more thermal power. Thus, in the region as a whole, generation by thermal plants rose from 56.2 per cent in 1962 to 69.5 per cent in 1967, to 74.6 per cent in 1972 and to 79.7 per cent in 1973. This was mainly due to the availability of clean fuel oil at reasonably cheap prices. But the trend started to turn the other way from 1974 dropping to 77.5 per cent in that year and further to 77.3 in 1975, then recovering to 81.6 per cent in the year 1978. (That anomaly, however, was only due to the rapid increase of nuclear power also counted as thermal.)

/Figure I

Source: Based on the latest publications of Electric Power in Asia and the Pacific.

Notes: Excludes China and some other countries for which data were available.

a/ Percentage increases over previous year.

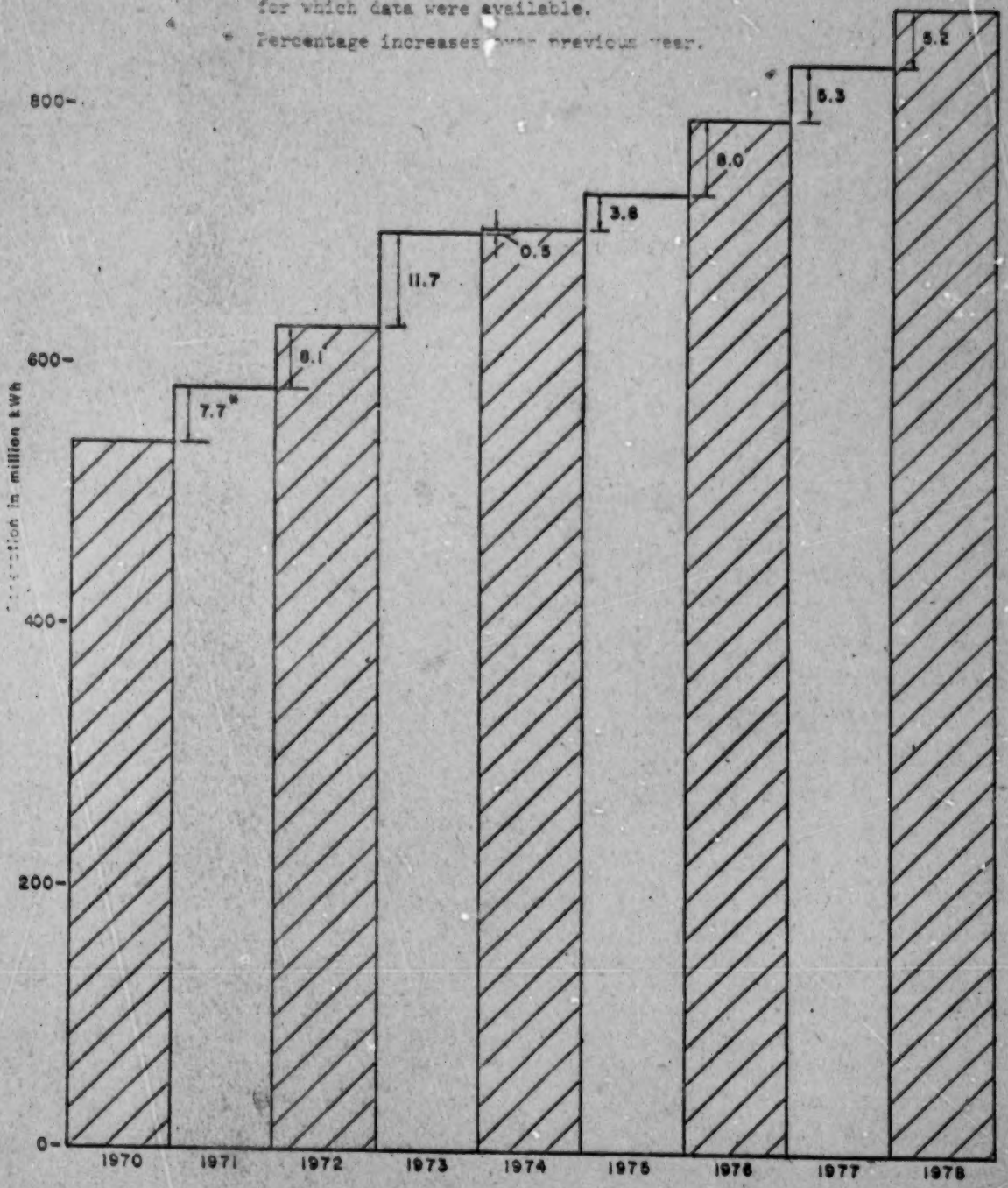

Figure I. Generation and its growth rate in ESCAP region by year

Source: Based on the statistical summary of Electric Power in Asia and the Pacific for the respective years.

Notes: 1) Excludes China and some other countries for which data were not available.

2) To facilitate sectorial breakdown data from respective years' publication were chosen and may not correspond to all those shown in figure I.

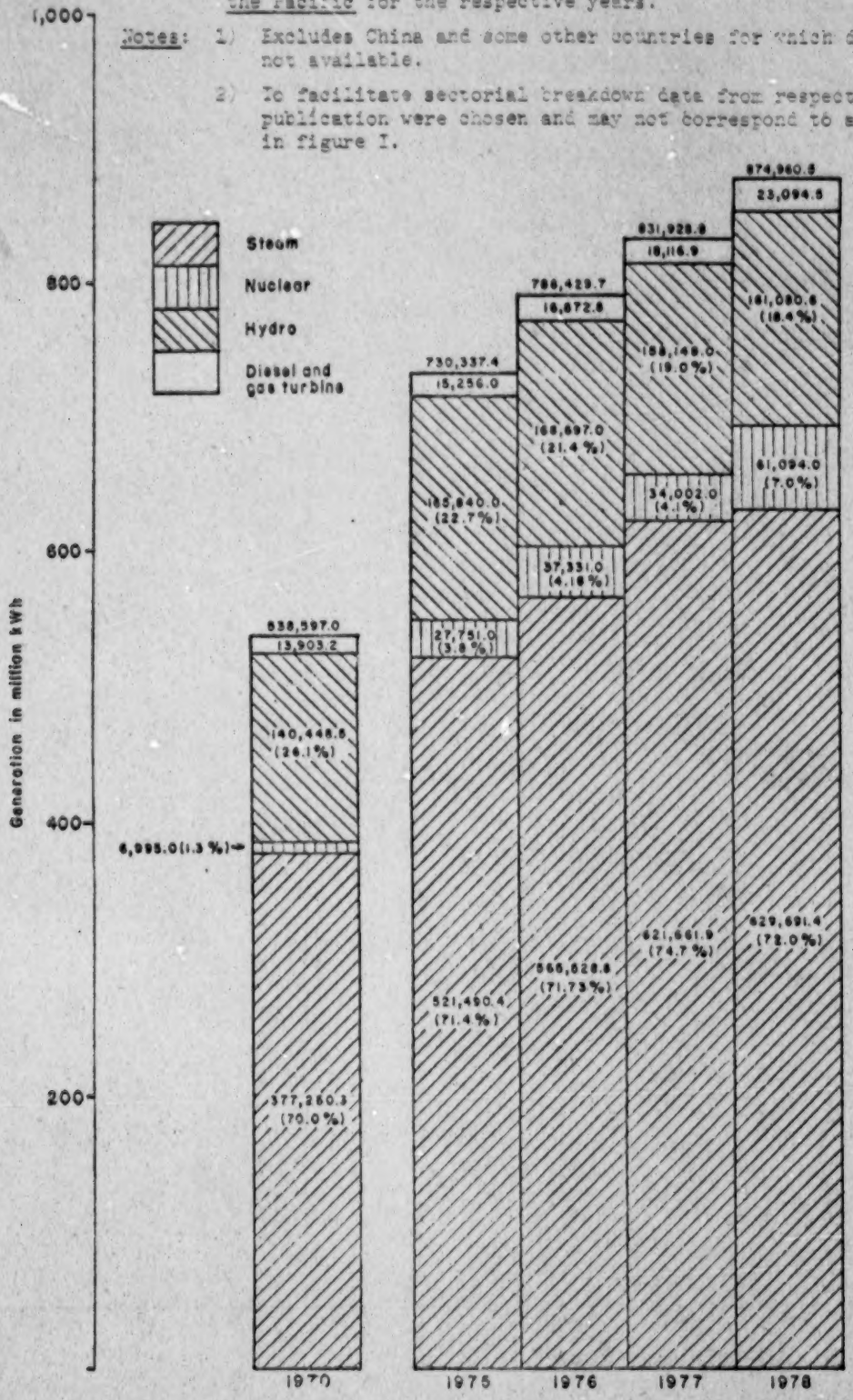

Figure II. Generation by class of prime mover in the ESCAP region

Figure II represents the regional status of electricity generation by class of generator prime movers. Taking 1970 as reference year, the generation in different sectors during the post oil crisis period can be observed.

C. STATUS OF PER CAPITA GENERATION

Most of the countries of the region are developing countries and they had very low per capita electricity generation in the past. Table 8 represents a picture of the per capita generation in some of the countries of the region.

Table 8

Per capita generation in some of the countries and areas of the ESCAP region 1978a/
(kWh per annum)

Afghanistan	54.1
Australia	5 558.6
Bangladesh	22.8
Brunei	1 719.8
Cook Islands	607.0
Hong Kong	2 252.0
India (1977)	157.3
Indonesia	33.3
Iran	561.0
Japan	4 857.0
Kiribati	206.5
Malaysia:	
Peninsular Malaysia	669.9
Sabah	374.0
New Zealand	6 933.0
Philippines	346.2
Republic of Korea	894.0
Samoa	183.2
Singapore	2 526.6
Sri Lanka	97.2
Thailand	292.0

Source: Electric Power in Asia and the Pacific, 1977 and 1978.

a/ No data were available for other countries.

D. ELECTRICITY DEVELOPMENT (PAST TRENDS AND FUTURE PROJECTIONS)

Apart from the developed countries of the region, only a few countries had substantial per capita generation. Most are well below the average of world developing countries. If economic development is to take place in these countries, a rapid growth of electricity demand can be expected. A World Bank study on energy in the developing countries, carried out in August 1980, estimated a growth of 8-9 per cent annually in the developing countries' electricity consumption during the next decade. The installed generating capacity of the ESCAP countries during the last few years is shown in table 9.

Table 9

Installed generating capacity of the ESCAP countries[a/]
(Megawatt)

Country or area	1975	1976	1977	1978
ESCAP region	229 130.4	241 109.8	259 278.6	276 915.8
Developed countries	137 480.4	142 815.6	149 869.9	160 500.8
Australia	20 157.8	20 579.0	21 893.9	23 660.8
Japan	112 285.0	116 871.0	122 343.0	131 217.0
New Zealand	5 037.6	5 365.6	5 633.0	5 623.0
Developing countries	91 650.0	98 294.2	109 408.7	116 415.0
Energy-exporting countries	48 946.5	53 980.1	60 116.9	65 279.4
Afghanistan	284.0	284.0	393.3	395.9
Brunei	81.0[b/]	96.0[b/]	141.8	141.8
Burma[b/]	437.0	441.0	452.0	454.0
China[b/]	41 000.0	44 000.0	47 000.0	50 000.0
Indonesia	1 098.8	2 552.4	3 239.0	3 682.1
Iran	4 850.0	5 130.0	7 105.0	8 589.0
Malaysia:				
Peninsular Malaysia	1 033.7	1 310.9	1 591.1	1 779.0
Sabah	71.6	73.8	97.0	104.0
Sarawak	90.4	92.0	97.7	133.6
Energy-importing countries	42 703.5	44 314.1	49 291.8	51 135.6
Bangladesh	818.3	818.3	934.0	920.0
Cook Islands	2.5	2.5	5.4	5.4
Gilbert Islands	1.2	2.4	...	...
Democratic Kampuchea[b/]	50.0	50.0	50.0	52.0

Table 9
(continued)

Country or area	1975	1976	1977	1978
Fiji	85.1	103.6	107.0[b]	109.0[b]
Hong Kong	2 595.3	2 920.3	3 120.3	3 100.3
India	22 249.0	23 755.0	26 175.0	26 175.0
Kiribati	1.0[b]	2.0[b]	2.4	2.4
Lao People's Democratic Republic	55.0	55.0	65.0	65.0
Maldives[b]	1.0	2.0	2.0	2.0
Mongolia	266.0	279.5	330.0[b]	340.0[b]
Nauru[b]	9.0	9.0	9.0	10.0
Nepal	60.1	62.3	62.0[b]	64.0[b]
Pakistan[b]	2 697.0	2 775.0	3 300.0	3 305.0
Papua New Guinea[b]	254.0	282.0	297.0	317.0
Philippines	3 231.0	3 275.0	3 578.0	3 623.0
Republic of Korea	5 239.0	5 340.0	6 337.0	7 662.0
Samoa	9.4	9.4	9.6	10.3
Singapore	1 030.0	1 390.0	1 390.0	1 610.0
Solomon Islands	6.1	6.2	11.0[b]	12.0[b]
Sri Lanka	361.0	361.0	401.0	401.0
Thailand	2 754.3	2 775.4	3 088.1	3 331.2
Tonga[b]	3.0	3.0	4.0	5.0
Trust Territory of the Pacific Islands	25.0[b]	35.0[b]	14.0	14.0
Tuvalu	0.2	0.2	...	...
Viet Nam[b]	900.0	...	...	...

Source: a/ Electric Power in Asia and the Pacific.

b/ 1979 Yearbook of World Energy Statistics, including estimated figures the by United Nations Statistical Office. No data were available for Bhutan.

The developing countries of the region have recorded a growth of 7.9 per cent annually during the last three years compared with 5.3 per cent for the developing countries. Therefore the developing countries of this region are expected to at least keep to the world developing countries' forecasted growth rate of 8 to 9 per cent annually. Another division of the developing countries of the region into energy-importing and energy-exporting countries would be of more importance as far as demand management is concerned. Thus it can be seen

/that

that the annual growth rate for energy-importing developing countries of the region (including India) was only 6.2 per cent compared with 10.1 per cent for the energy-exporting countries during the last few years. However, assuming an 8 per cent growth rate for the developing countries as a whole and 5.5 per cent for the developed countries, the expected growth in the region can be statistically exyrapolated as shown in table 10.

Table 10

Projected electricity generating capacity of the ESCAP countries
(Megawatts)

	1980	1985	1990	1995
Developing countries	135 786.5	199 514.8	293 152.7	430 737.4
Developed countries	178 641.4	233 477.1	305 145.2	398 812.6
Regional total	314 427.9	432 991.9	598 297.9	829 550.0

E. HYDROELECTRICITY

During the period 1970-1978 the share of the hydroelectric capacity was diminishing, although at a lower rate during the later years. Thus, in 1978 the share of hydroelectricity in the regional capacity was only 23.8 per cent compared wtih 31.5 per cent in 1970, including developed countries. For the developing countries hydroelectricity's share was 32.4 and 25.3 per cent respectively, in the years 1970 and 1978. Despite the fact that there is a substantial hydroelectric potential in many of the developing countries of the region, the development in this sector was not satisfactory. Table 11 shows the estimated potential and its exploitation in the countries of the region as of 1978.

/Table 11

Table 11

Water power potential and development in the ESCAP countries[a/]

Country or area	Capacity (in thousands of KW) Estimated potential	Stalled capacity	Ratio of exploited capacity to estimated potential (percentage)	Basis of method of estimation
Afghanistan	5 000.0	258.7	5.2	
Australia	9 765.0	6 113.1	62.6	Mainly based on Q average flow of respective states at different load factors
Bangladesh	371.6	80.0	21.5	Q average flow
Bahutan[b/]	2 000.0	5.0	0.15	Q 95 at 40 per cent load factor
Burma[b/]	2 000.0	100.6	5.0	Economic potential at about 60 per cent load factor
Fiji[b/]	100.0	-	-	60 per cent load factor
India[c/]	100 000.0	11 516.0	11.5	Economic potential at 60 per cent
Indonesia	31 500.0	620.0	1.96	Q average flow
Iran	14 000.0	1 804.0	12.9	Economic potential
Japan	51 499.0	22 509.0	43.7	Economic potential
Malaysia:				
Peninsular Malaysia	2 190.0	354.8	16.2	Economic potential at 60 per cent load factor
Sarawak	10 000.0	-	-	60 per cent load factor
Nepal[b/]	83 000.0	36.4	0.04	Q average flow
New Zealand	8 453.0	3 729.0	44.1	Mean flow. Relating to North and South Islands
Pakistan[b/]	10 400.0	682.6	6.6	
Papua New Guinea[b/]	14 228.6	49.6	3.5	Various sites, based on estimated flow at 80 per cent load factor
Philippines[c/]	8 000.0	933.0	11.7	Average flow
Republic of Korea	3 000.0	700.0	23.3	Technical power potential at 60 per cent load factor
Samoa	13.8	1.3	9.4	Average flow
Sri Lanka	1 540.0	326.0	21.2	Technical power potential
Thailand	22 344.0	910.0	4.1	Q average flow
Viet Nam[b/]	5 023.0	164.0	3.3	Technical power potential

Source: Electric Power in Asia and the Pacific (excluding[c/]).

a/ No data were available for China, Democratic Kampuchea, the Lao People's Democratic Republic, Maldives, Mongolia, Sabah, Solomon Islands, the Trust Territory of the Pacific Islands or Tuvalu.
No estimate was made for Brunei, Hong Kong, Nauru or Tonga.
No water power potential exists in Cook Islands, Kiribati or Singapore.

b/ Preliminary figures not confirmed or latest figures not available.

c/ Figures were taken from country reports on new and renewable sources of energy (1980).

Table 11 shows that in the developing countries only 18,542.0 MW or 5.9 per cent of the estimated hydro potential of 314,711.0 MW have been exploited compared with 46.4 per cent in the developed countries. If by 1995 half the estimated potential could be developed for electricity generation, it could meet 36.5 per cent of the total estimated capacity requirement of the developing countries. Considering all sorts of constraints such as accessibility, environmental implications, etc., it would not be unreasonable to foresee such a development if the problems of financing could be managed. Another problem that still remains is that of tapping the power from the source and transferring it to the demand areas. As can be seen from table 11, high potential areas are not high load centres. This problem could be solved by subregional or regional co-operation through "electricity trade". Since a lead time of about five years or more is needed for a hydro-electric project, immediate planning is required to be undertaken for medium- and long-term programmes. Maximum developments may be expected in the late 1980s, when the costs are also likely to be more competitive. The trend of only about 4 per cent growth rate in the recent past is very discouraging. (However, until 1980, an estimate using 4 per cent growth was assumed.). The energy crisis may help to boost progress in the 1980s, especially in the late 1980s, and again it may decrease in the 1980s as accessibility will become increasingly difficult and development more expensive. Therefore, keeping the 1995 target of 50 per cent exploitation of the hydro potential, the distribution may be assumed to be 6 per cent by 1980 (expected), 20 per cent by 1985, 40 per cent by 1990 and 50 per cent by 1995. On the basis of this assumption, the projected hydroelectric capacity (in MW) in the developing countries, excluding China and other countries mentioned in footnote[a/] of table 11 for 1980, may be as follows:

1980 (expected)	1985	1990	1995
18 882.7	62 942.2	125 884.4	157 355.5

The figures thus derived are interesting and encouraging. But it may be noticed from table 11 that the potential of water resources in some less developing countries such as Nepal are very high, and it might not be possible to develop even half of these because of the remoteness of the sources and very low demand in the individual countries. From the UNDP Governing Council documents DP/GC/NEP entitled "Country and intercountry programming and projects - joint programming of resources-26: country programme for Nepal for the period July 1980-December 1985" it is understood that projects being planning and under consideration for 1980-1985 would total about 3,854 MW, with a subsequent project study to assess the water resources of two of Nepal's three major river basins, believed to have a potential of 22,000 MW. So, even if those two basins are developed for power, harnessing the total power output would mean about 25,918 MW, or 31.2 per cent of the estimated potential. Similarly, 50 per cent development of Sarawak's (Malaysia) hydro potential is unlikely, and this might be the case with some other countries. Therefore this target is only plausible if interrregional co-operation for developing the resources takes place, with a network of transmission lines among the countries of the region or subregion.

To be more realistic, and taking the example of the developed countries as a precedent, a development of about 40 per cent may be more practical. With this assumption, and using the phasing described before, a development of 15, 30 and 40 per cent by 1985, 1990 and 1995 respectively may be expected. The likely installed capacity of hydroelectricity in the developing countries of the region (in MW), excluding China and other countries mentioned in footnote[a/] of table 11 for 1980, is as follows:

1980 (expected)	1985	1990	1995
18 882.7	47 206.7	94 413.3	125 884.4

F. NUCLEAR POWER PLANTS

With continuous depletion of fossil fuels and uncertainty of supply, more attention is now being paid to nuclear power. Developing countries are also stepping forward into this new technology. Thus, in planning long-term energy policies, particularly in electic power generation, nuclear power may play a significant role. Apart from Japan, in the ESCAP region the countries which already possess nuclear power plants are India, Pakistan and the Republic of Korea. The Philippines is expected to be the next country in this region to acquire nuclear plants in the near future. According to Alan M. Strout,7/ other countries of the region which may start with nuclear technology are Iran, Thailand and Singapore. Although Bangladesh and Indonesia have also been included in the list, the author raised some doubts about these, using the argument that these countries may give second thoughts to the active exploitation of coal and/or gas instead. Another constraint in accepting nuclear power plants is that the countries with smaller electric power systems have size limitations. Because of economic disadvantages, reactors smaller than 600 MW are not commercially available. However, the International Atomic Energy Agency (IAEA) is said to have been actively promoting the idea of the existence of a smaller nuclear plants market. If that idea materializes, nuclear power development in the developing countries could be quite widespread. In the same article, the author has proposed an adjustment to the IAEA projections of nuclear potential. According to the author, nuclear power may represent 19 per cent of total generating capacity in 1990 and 36 per cent by the year 2000, as against IAEA's projection of 37 per cent in 1990 and 59 per cent in 2000 respectively. These adjusted shares seem to be more realistic. The total installed generating capacity of the developing countries of the ESCAP region which are expected to have nuclear power plants were 68,697.4 MW in 1980. Assuming the same growth rate of 8 per cent as of the developing countries of the region, their projected total installed capacity in the years 1990 and 1995 would be 148,313.4 MW and 217,921.0 MW respectively. Taking an average of around 28 per cent for 1995, nuclear's share for those countries (and thus of the developing countries of the region) may be projected as follows. The figures for 1980 and 1985 are taken from Electric Power in Asia and the Pacific.

/G.

7/ "Nuclear power in developing countries", in Robert S. Pindyck, Advances in the Economics of Energy and Resources, 1979, vol. 1.

G. OTHER FORMS OF ENERGY

Except for hydro, other new sources of energy that have long-term prospects in the field of electricity generation include geothermal, wind power, solar thermal conversion, solar photovoltaic conversion, ocean thermal energy, wave power, tidal power, fuels derived from biomass and biogas. While the technology for conversion of geothermal energy to electricity is available, already a UNDP panel expects that small-sized and medium-sized wind-powered electric power generation technology will be economically viable within the next five years.8/ It is also believed that land-based turbines supplying electric power into grid networks may become commercially viable in 5 to 10 years time and by the turn of the century could be supplied from off-shore systems. The countries of the region which possess geothermal power plants are China, Indonesia, Japan, New Zealand and the Philippines, while many other countries are continuing their efforts in the assessment, as well as experimental drilling, of these resources. Table 12 indicates the geothermal development in some of the countries of the region. What emerges is that no reliable assessments are available for most of the countries' potential of all the new sources of energy. However, geothermal energy development is in the lead at the moment. Because of the lack of data on potential, it is difficult to determine to what extent exploration might take place. Compared with the total generating capacity of the countries of the region, geothermal generation is very insignificant, but still it represents quite a big step towards utilizing new sources of energy. Thus, it is observed that geothermal capacity was only 0.25 per cent of the total generating capacity for the region (0.33 per cent for the developing countries) in 1980. From planned targets, it can be seen that in 1990-1995 geothermal may take a share of 1.5 per cent of the total installed capacity in the developing countries. This seems to be little more than the World Bank's estimate of 0.8 per cent in 1990 for the world developing countries.9/ As far as the other new and renewable sources of energies are concerned, tidal and wind power are expected to come into use, followed by photovoltaic cells, in electricity generation. In these fields too no reliable data are available in most of the countries of the region. One ambitious tidal project of 400 MW is expected to be taken up by the Republic of Korea. India is also believed to take up some projects in selected areas. At the moment, some experimental wind

/mills

8/ See Conference News 5 on the United Nations Conference on New and Renewable Sources of Energy.

9/ See International Bank for Reconstruction and Development, Energy in the Developing Countries, August 1980.

mills of the order of kWs are installed in some countries. In the solar field some solar pump sets (30 kW) have been developed in India for demonstration; certain other countries are also doing research. However, if the technology became acceptable economically, it might help rural electrification, particularly in the agricultural sector. The possibility of electricity generation in some hundreds of megawatts is there from biomass and biogas. Ocean thermal energy may still be in the pilot scheme status during the projected time period.

Table 12

Geothermal development in the ESCAP countries

Country	Electricity generation (in MW)	Estimated/planned potential (in MW)
China[a/]	0.4	3.4 (planned 1990)
India[b/]	-	9.8×10^{18} Joules
Indonesia[b/]	0.25	10 000.0
Japan[c/]	152.0	7 000.0 (by 1995)
New Zealand[b/]	192.0	294.0 (by 1986/1987)
Philippines[b/]	443.0	3 488.0 (planned)

Sources: a/ OLADE's (Latin American Energy Organization) publication on regional co-operation activities (1980).

b/ Report of the Seminar on Geothermal Energy, ESCAP, 3 December 1980.

c/ Electric Power in Asia and the Pacific.

H. SUMMARY

From the discussions so far, it can be concluded that the rest of the projected capacity must be met by the conventional hydrocarbon-based fuels such as oil, gas and coal/liquid, including their derivatives. Table 13 is thus the summary of the projections and estimates provided so far.

/Table 3

Table 13

Likely scenarios of the installed generating capacities of the ESCAP developing countries

	1980		1985		1990		1995	
	Megawatts	Percentage	Megawatts	Percentage	Megawatts	Percentage	Megawatts	Percentage
Thermal (oil, gas, coal/liquid)	114 888.2	84.6	145 309.5	72.8	167 628.4	57.2	237 361.8	55.1
Hydro	18 882.7 a/	13.9	97 206.7	23.7	94 413.3	32.2	125 884.4	29.2
Nuclear	1 572.0	1.2	6 001.0	3.0	28 179.5	9.6	61 017.8	14.2
Geothermal	443.7	0.3	997.6	0.5	2 931.5	1.0	6 473.4	1.5
Total	135 786.6	100.0	199 514.8	100.0	293 152.7	100.0	430 737.4	100.0

a/ Same as table 11.

I. THERMAL POWER

Although the share of thermal energy consumption is expected to be reduced from 84.6 per cent in 1980 to 55.1 per cent in 1995, the actual installed capacity quantity will increase to more than twice the 1980 figure (table 13). This high demand is to be met by traditional fuels such as oil, gas and coal. In the first part of this study, the development of hydrocarbon-based fuels has been discussed. In short, coal and gas are likely to meet a larger share of required thermal energy during the projected period. Accordingly, in the electric power industries, the present share of oil is likely to diminish with the increased use of coal and natural gas. This may be evident from some of the country programmes where emphasis has been given to more use of coal and natural gas. As far as the total energy resources are concerned, natural gas is thought to be one of the most important transition energy resources in the region for the next few decades. For the fossil fuel resources of the countries of the region, see tables 1, 2 and 3.

Compared with the world developing countries' consumption of fossil fuels by power plants, the ESCAP developing countries consume much more. Although the figures for 1980 (table 13) are not representative because of the unavailability

/of hydroelectricity

of hydroelectricity data for China, the statistics of 1978 (excluding China) indicated that the share of thermal power plants was about 73.2 per cent. The World Bank's study, Energy in the Developing Countries, estimated the share of thermal power to be 57.1 per cent in 1980 and forecasted it to be 55.8 per cent in 1985 and 53.9 per cent in 1990 for all developing countries. By a further classification of the above percentages, the shares of oil, gas and coal/lignite have been shown as 31.3, 8.3 and 16.2 respectively in 1985 and 24.7, 11.6 and 17.4 in 1990. Because of the lack of sectoral data for the ESCAP regional countries, the present share of gas cannot be estimated. This is also due to the fact that many of the present thermal power plants of the region are dual-fired and use gas only when available. Data on coal-fired boilers give some indication that the share of coal may be higher than the estimate given by the World Bank. However, since reliable data are not available, the relative shares taken by the World Bank for oil, gas and coal are assumed for projection purposes for the ESCAP developing countries as well, in order to estimate the figures for 1985 and 1990. For 1995, since no forecast is available beyond 1990, the growth rates of 15 and 10 per cent per annum respectively for gas and coal (from the World Bank 1985-1990 forecasts) have been chosen for projection purposes, taking oil to be in the residual. Thus, the following estimate is obtained for thermal power plants' fuel breakdown in the ESCAP developing countries.

Table

Thermal power plants' fuel breakdown
projection of the ESCAP developing countries

	1985		1990		1995	
	MW	Percentage of total thermal	MW	Percentage of total thermal	MW	Percentage of total thermal
Total thermal	145 309.5	100.0	167 628.4	100.0	237 361.8	100.0
Oil	81 518.6	56.1	76 773.8	45.8	76 593.0	32.3
Gas	21 651.1	14.9	36 040.1	21.5	72 489.5	30.5
Coal/lignite	42 139.8	29.0	54 814.5	32.7	88 279.3	37.2

The interesting aspect of this scenario is that there is a decrease in actual oil use as opposed to the approximate 3 per cent estimated increase in the World Bank's forecast. It is at the same time important to note that to minimize the dependency on oil (at least to the world developing countries' level) the development and increased use of coal and gas have to be achieved in the future.

J. CONCLUSION

Despite the energy crisis, the development of electric industries and electricity consumption in the countries of the region maintained a fairly steady growth, although at a considerably lower rate after the 1973 oil price rise. Another important achievement in the past was the trend away from oil to other forms of energy in the electrical industries. In the worldwide effort to develop alternative energy resources this region has taken an active part, but the progress has been rather slow and applications have been limited. It is evident that several countries are still heavily dependent on imported energy (particularly oil) and are expected to remain so for some years to come.

The important thing for today and for the future is not just the energy crisis, but the efficient development and use of existing resources of the region. For this, appropriate action is required.

As far as electric power generation is concerned, the highest priority is to be given to power development since per capita generation in most of the countries is even lower than the developing countries' average. To increase economic development to sustainable levels, projected power generation targets should be achieved, if not exceeded. The above future projections do not represent a highly ambitious programme. Nevertheless, these developments represent a challenge at the present stage. Growth, particularly in the hydroelectric sector, should not be allowed to follow its present low trend, but needs to be increased. Similarly in the thermal sector, special emphasis should be given to the increased development of gas and coal. The above developments could be considered a technical extrapolation, assuming similar capacity utilization as at present (as low as 50 per cent in some countries). Higher utilization, interconnected grids, etc. would reduce the total technical capacity requirements. Financial constraints might also limit the expansion to less than technically feasible levels.

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